Application of Thermally Enhanced Vapor Extraction at Berkeley Lab

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OBJECTIVE

A plume of contaminated groundwater was found near the site of the first Berkeley Lab cyclotron. Detailed investigations have identified the source area and determined the vertical and lateral extent of the contamination in the subsurface. The contaminants are chlorinated hydrocarbons consisting mainly of perchloroethene, trichloroethene, and carbon tetrachloride. The source area is located within heterogeneous geological materials consisting of both volcanic and sedimentary rocks. The hydraulic conductivity of these materials varies between 10^{-5} and 10^{-9} m/s. Various technologies are being tested to study their applicability for cleaning the source area. The objective of this study was to examine the effectiveness of thermally enhanced vapor extraction in removing contaminants from the source area.

APPROACH

In a pilot-scale test, we used a combination of soil heating and vapor extraction techniques to remove the chlorinated hydrocarbons from very-low-permeability geological materials of the source area. Three heaters, each of approximately 5.3 kilowatts capacity, were placed in three wells at 20 to 40 ft depth. Heater wells were drilled 6 ft apart, at the apexes of an equilateral triangle. Resistive heating raised soil temperature to a maximum of 200°C. Both liquid and vapor were extracted from a well at the center of the triangle. Two instrumented wells were installed within 5 ft of one of the heaters. Temperatures were measured along the heater well casings, the extraction well, and at various depths in the instrumented wells. In addition, soil gas probes and vacuum lysimeters were installed at various depths in the instrument wells. Soil vapor and soil water from all sampling points were collected and tested periodically, while flow rate and chemical composition of soil gas samples collected at the top of the extraction well were measured. The test continued for about 18 months.

ACCOMPLISHMENTS

More than 500 kg of perchloroethene, trichloroethene, and carbon tetrachloride were removed from the source area. This estimate is based on the measured flow rates and concentrations of contaminants in the extracted air. Note that the total mass of dissolved chlorinated hydrocarbons in the groundwater plume before this experiment was estimated to be about 7 kilograms.

SIGNIFICANCE OF FINDINGS

- Thermally enhanced vapor extraction proves to be an excellent technique for removing dispersed nonaqueous-phase liquids from very-low-permeability heterogeneous geological materials.
- If the test were not properly designed, some of the chemicals volatilized may diffuse and condense into areas that were previously clean.

ACKNOWLEDGMENTS

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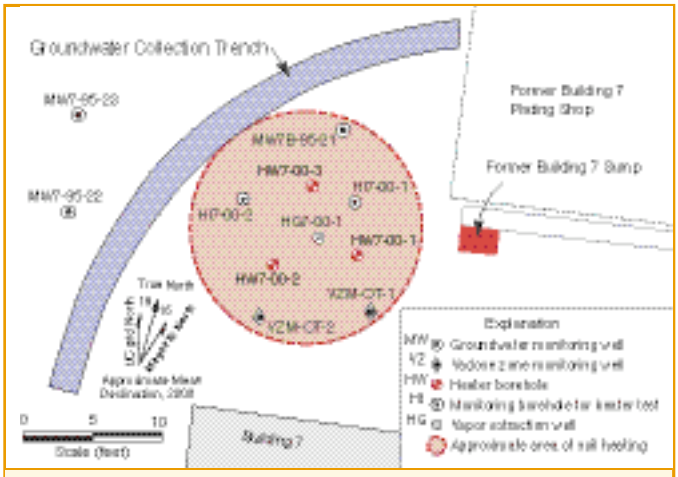

Figure 1. Location of thermally enhanced vapor extraction pilot test.